

Space Weather Technical Forecast

Issued on Saturday, 19 November 2022 at 12:42 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storms peaking later in the UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been at Low levels over the past 24 hours, with occasional C-class X-ray flares observed at GOES16, on a very slightly decreasing background. The main source of the larger flares and the peak event of a C8.4 at 19/0623UTC was a sunspot region in the northwestern quadrant that underwent rapid growth in the period, numbered AR3150 and reaching Dai/Beta complexity, although its growth phase gave way to spreading to end the UTC morning. This was one of four numbered sunspot regions on the facing side at present, with the other three all in the eastern solar hemisphere. From north to south, these were AR3149, which saw proliferation in its leading spots to reach Bxi/Beta; AR3147, which was relatively stable at Cho/Beta, with minor changes in small low-latitude spots; and finally AR3148, which manifested as a Cro/Beta and also saw some leader development as well as a small C-class flare.

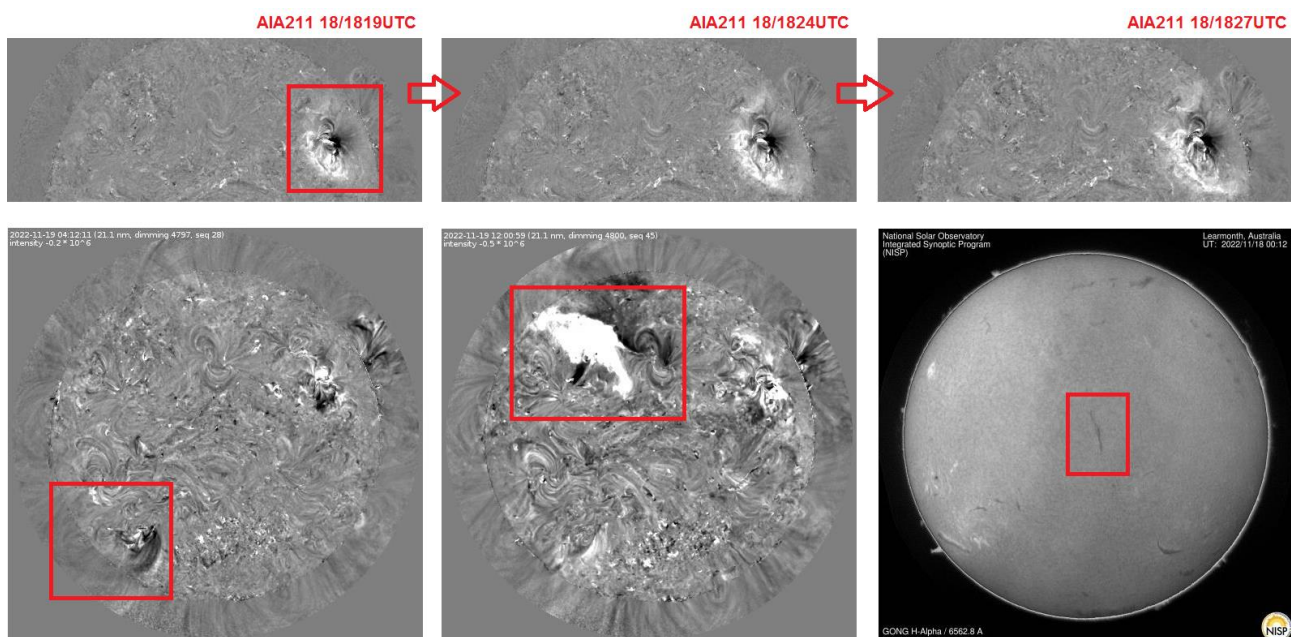


Figure 0: Potential CME-producing events of note in the past 24 hours (clockwise from top left): SIDC ROB-processed image of AIA211 EUV wave emanating from the C8.4 flare from AR3150; A disappearing filament (probably re-absorbed) from near centre-disc on H-Alpha; a northeast disc filament eruption 19/0700-1000UTC, also visible in AIA304 (not shown); a small possible CME seen following a C2 flare from AR3148 after 19/0200UTC

There were a few potential Coronal Mass Ejection (CME) progenitors seen on the front side in the period, however at the time of writing there is no evidence of any in available coronagraph
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imagery. Firstly, a filament near the centre-west disc was seen to gradually fade in H-alpha imagery in the 24 hours, however there was no obvious lift-off. The peak X-ray flare of the period from AR3150 showed an EIT-wave signature, but this does not appear to have translated to any interplanetary CME element. A smaller flare from AR3148 at around 19/0200UTC showed possible ejecta on AIA211 for example, while AIA304 showed a large filament detach from the northeast disc between 19/0700-1000UTC. This final event may have remained anchored at its southern end near 40N20E, which may have put any ejecta on a more Earth-orientated track than would otherwise be possible from such a peripheral starting location. All these events are being monitored.

Current coronagraph imagery suggests a possible far-sided southwest-directed CME and perhaps now also faint northeastward and westward emissions, all pending analysis, however at present, no conclusively Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1 showed three main phases during the period. Firstly a possible weak transient influence ongoing since 18/0845UTC, which gave way to an increased magnitude feature from 18/1630UTC with varying magnetic field orientation, and finally a discontinuity at 18/2230UTC left a larger magnitude but steady field as well as an increase solar wind speed, albeit still within normal background. The cause(s) of the above are not entirely clear, however the 14 November CME is believed to form at least part of the signature, with CH46/- still perhaps unaccounted for.

The solar wind speed showed a gradual increase from 310km/s, jumping to nearer 380km/s after 18/2230UTC, with a peak of 390km/s observed later in the UTC morning. The solar wind density peaked near 15ppcc shortly before the main speed increase, else mainly residing nearer the long-term average in single figures ppcc. The IMF rose in steps: from near 5, to near 10, to a peak of near 12nT. The north-south component varied from peaks of -10 to +10nT, with an initial anti-aligned bias reversing to become mainly co-aligned (with Earth's field) as the period went on. The phi angle was mostly negative (towards the Sun), but spent a spell in positive territory into the UTC evening.

The net effect of the above solar wind measures was for mainly Quiet geomagnetic indices, but with a provisional peak Kp of 3+ in the 21-24UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has remained at Background levels.

High energy electron flux (greater than 2 MeV) at GOES16 started at mainly Moderate levels, with a peak of 508pfu at 18/1910UTC, but underwent a lasting fall to Normal Background counts after 19/2000UTC. Electron fluence levels remained well below Active ($1e8$ integrated pfu) levels, with a level trend. Observed fluence at 19/0001UTC was $7.77e6$ integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low, with further C-class flares Likely, and with a Slight Chance of M-class flares. The main risk is from sunspot AR3150 in the northwest.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs that feature in this forecast period.

Initially background winds are expected to become enhanced due to the arrival of fast wind from CH46/-, although confidence is low on the timing of the arrival. Any preceding CIR region is likely to arrive later day 1 (Saturday 19 November), with a transition into the fast wind through day 2 (20 November). Fast winds are then likely to persist into the new working week before reducing to end the four-day period.

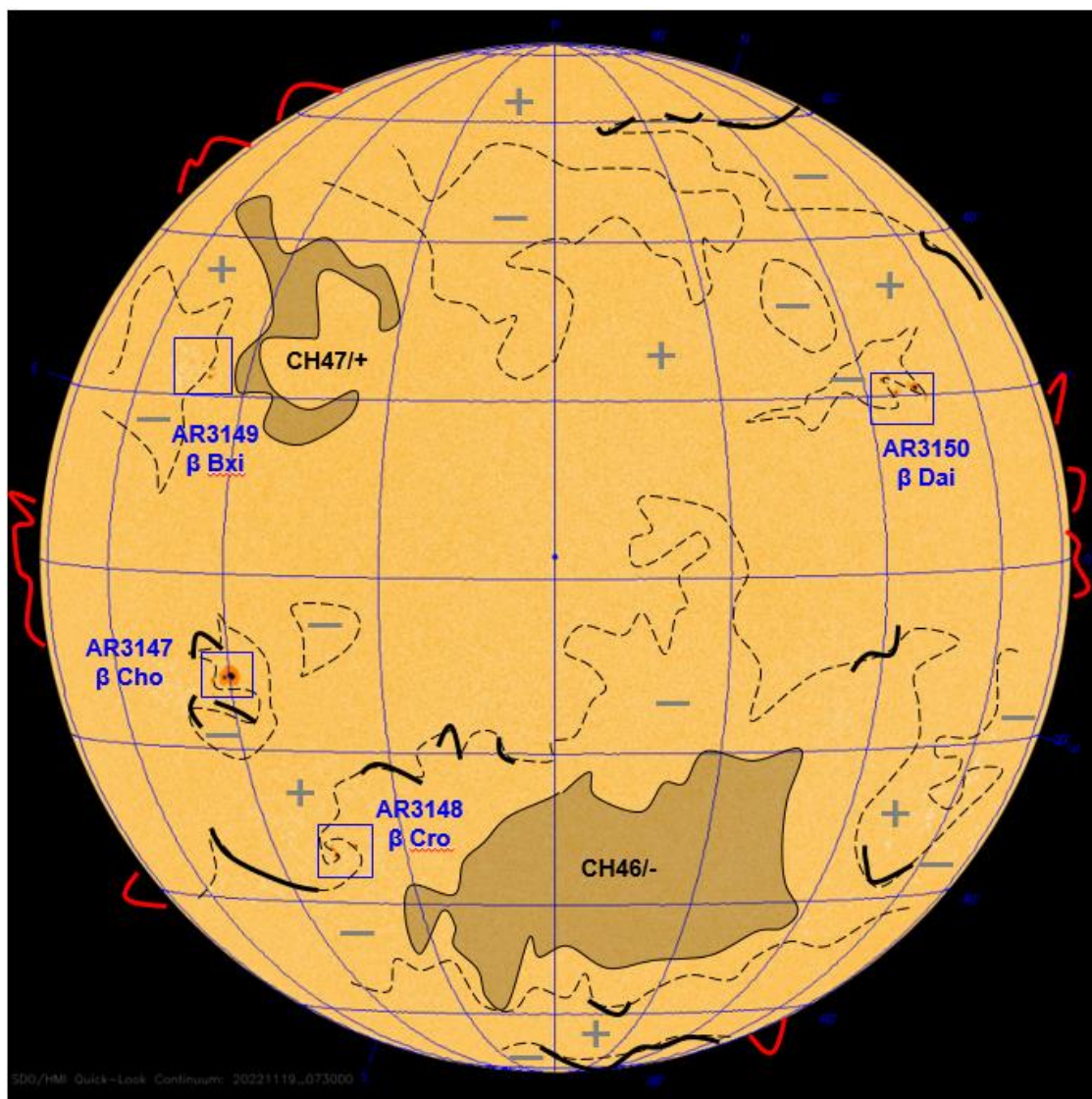
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Initially Quiet geomagnetic activity is Likely to give way to Active intervals and a Chance of G1, with this peaking on Sunday 20 November with the effects of CH46/-. More reliably Quiet Kp should begin to be restored to end the forecast period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to remain at Background levels throughout.

Electron flux is forecast to be initially at Normal Background, but with a Chance of rising to Moderate, perhaps High, later in the period as solar winds ease after any enhancement from the arrival of CH46/- fast winds. Fluence values are expected to remain below or well below the Active (1e8 integrated pfu) threshold throughout, but with an eventual Chance of rising above on day 4 (Tuesday 22 November).

Figure 1. Solar Analysis Valid 19/0730UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are no Earth-directed CMEs that currently feature in this forecast period.

Solar winds are currently at background with the next significant enhancement expected to be from a fast wind arrival, with the onset of the high speed stream (HSS) of negative polarity coronal hole 46, although the timing of this arrival is low confidence.

This is a broad feature in the southern hemisphere with 27-day persistence suggesting the arrival of any associated Co-rotating Interaction Region (CIR) ahead of the HSS occurring during the 2nd half of day 1 (Saturday 19 November), whilst Enlil has the associated arrival early day 2, around 12 hours later. Despite the unfavoured time of year for a strong geomagnetic response, this is a persistent feature - perhaps indicating a stronger CIR than would otherwise be expected. Furthermore Enlil indicates a potential for solar winds to peak at around 600km/s by day 3 (Monday 21 November), before then easing gradually day 4 onwards.

The signal from STEREO A - currently around 1.2 days upwind of Earth in the Parker Spiral - is slightly puzzling, with no obvious fast wind enhancement visible, this despite being only 1.5 degrees further north than Earth relative to the solar equator and CH46/-. Because of CH46's low latitude this may however be the difference between marginal incidence (at Earth) and missing (STEREO A).

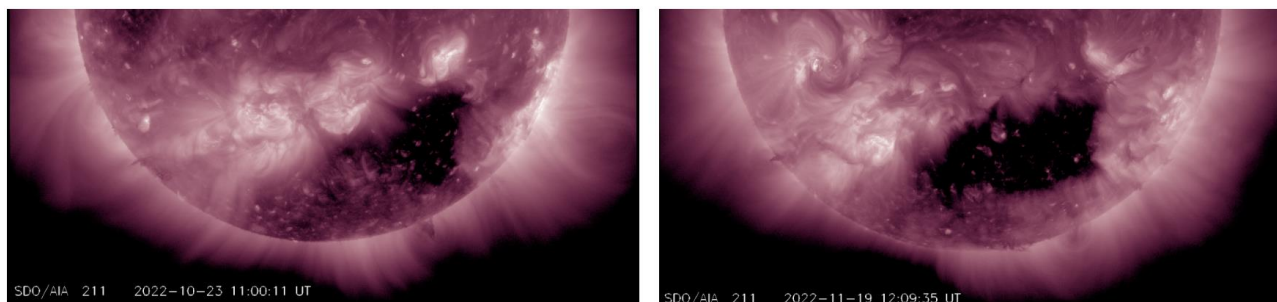
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Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	30	40	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: AIA 211 from the previous rotation and current, showing the feature's leading edge at roughly the same solar longitude (and latitude) on both occasions, with differences further east (after onset).



Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with occasional C-class flares and four small and relatively simple sunspots on the Earth-facing disc. This activity is forecast to continue with only a Slight Chance of M-class flares.

AR3150 Dao/Beta in the northwest is the most development region on the disc, with rapid growth observed from the second half of 18 November. This has subsequently staablised into a small and spreading region, but remains the most likely source of any M-class flaring day 1, with the subsequent risk decreasing due to low confidence with any further development. The other three regions are all smaller, simpler and largely stable.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	15	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: 24-hour change in footprint of AR3150 in AIA171 and HMIB – compare T-24 (white) with current (black), i.e. 18/1100UTC with 19/1100UTC, showing a marked growth trend. Also shown are the western solar horizon and Earth for scale.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16 is currently at background and expected to persist at this level.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	1	1	1	1
Very Active	$\geq \text{S3}^*$	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed by GOES16 is at mainly Background, briefly Moderate, levels, and well below the Active threshold.

A forecast solar wind enhancement later day 1 and through to day 3 (19-21 November) has the potential to increase the electron content in the Van Allen belts, although these will initially be compressed inside of GEO. As solar wind pressure eases later in the period, the observed flux is likely to rise, perhaps reaching Moderate to High levels. The strength of any response is very low confidence however, with no increased flux observed on the previous pass of this coronal hole, 27 days ago.

The associated 24-hour fluence is expected to remain below the Active ($1\text{e}8$ integrated pfu) threshold, but with a chance of rising above by day 4 (Tuesday 22 November). REFM is currently giving good guidance, however this will become less reliable with the expected solar wind enhancement.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	10	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1